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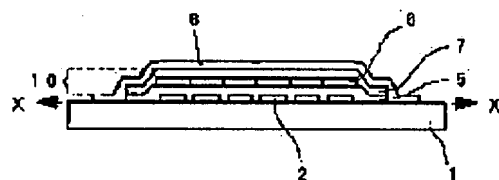
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(54) MANUFACTURE OF ORGANIC ELECTROLUMINESCENT ELEMENT

(57)Abstract:

PROBLEM TO BE SOLVED: To improve productivity of an element and reduce the cost by forming a thin film layer with n surfaces (n is an integer two or more) and a second electrode on one board and cutting the board into n sub-boards.

SOLUTION: This manufacturing method for an element, preferably, comprises the following processes. At least one of a luminescent layer and a second electrode is patterned in a mask deposition method, and n shadow masks are arranged for one board and then at least one of the luminescent layer and the second electrode is patterned. A first electrode is patterned on a plurality of stripe-shaped electrodes arranged spaced, the second electrode is patterned on the plurality of stripe-shaped electrodes crossing to the first electrode. A protecting layer is formed after forming of the second electrode, and the board is cut into n sub-boards, and thickness of the shadow masks is less than 500 μm . As a typical element structure, a positive hole transportation layer 5, an organic luminescent layer 6, an electron transportation layer 7, the second electrode 8 are laminated on the transparent first electrode 2 formed on the glass board 1, and a spacer 4 is formed between the second electrodes.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the manufacture approach of the organic electroluminescence devices available in fields, such as a display device, a flat-panel display, a back light, lighting, an interior, an indicator, a signboard, and an electrophotography machine, which can change electrical energy into light.

[0002]

[Description of the Prior Art] Research of the organic electroluminescence devices that the poured-in electron and the electron hole poured in from the anode plate recombine and emit light within the organic fluorescent substance inserted into two poles from cathode has come to be done actively in recent years. A thin shape, high brightness luminescence under low driver voltage, and multicolor luminescence by choosing a fluorescence ingredient are the descriptions, and this component attracts attention.

[0003] It was shown for the first time by C.W.Tang and others of Eastman Kodak Co. that organic electroluminescence devices emit light in high brightness by the low battery (Appl.Phys.Lett., 51 (12) 913(1987)). The typical configuration of organic electroluminescence devices shown here prepared Mg:Ag one by one with vacuum deposition on the glass substrate with which the ITO transparent electrode film was formed as the diamine compound of electron hole transportability, the 8-hydroxy kino RINARU minium which is a luminous layer, and cathode, and green luminescence of 1000 cd/m² was possible for it at about [10V] driver voltage. Current organic electroluminescence devices have followed C.W.Tang's and others configuration fundamentally, although there are some which are changing a configuration, such as preparing the electron transport layer other than the above-mentioned component component.

[0004] Examination which uses for a display device etc. these organic electroluminescence devices in which high brightness and multicolor luminescence are possible is also prosperous. However, pattern processing of a component has been one big problem as pointed out also to Nikkei electronics 1996.1.29 (No.654) p.102. For example, in the case of a full color display, it is necessary to form the luminous layer of red (R), green (G), and blue (B) in a position. Conventionally, although such pattern processing was attained by the wet process represented by the photolithography method, it is deficient in the organic film which forms organic electroluminescence devices in the endurance over moisture, an organic solvent, and a drug solution. Although it is also shown that the possible component of wet process is obtained by devising an organic material so that it may be represented by JP,6-234969,A, the organic material used for a component will be limited by such approach. Furthermore, there is a problem with the same said of pattern processing of the electrode of the organic layer upper part required for a display device.

[0005] Since it was such, conventionally, according to the dry process represented by vacuum deposition, organic electroluminescence devices were manufactured, and mask vacuum deposition was used for pattern processing, and it realized in many cases. That is, a shadow mask is arranged ahead [of

a component / substrate] and an organic layer or an electrode is vapor-deposited only to shadow mask opening.

[0006] Furthermore, the matrix system currently indicated by JP,5-275172,A, JP,5-258859,A, JP,5-258860,A, etc. is known as a patterning method do not use wet process. It is the approach of carrying out patterning by producing the septum of the shape of a stripe arranged in parallel on the substrate after the first electrode patterning, and vapor-depositing luminescent material and the second electrode material from the direction of slanting to a perpendicular direction and a substrate side to a septum to the substrate. Moreover, in the matrix system currently indicated by JP,8-315981,A, it vapor-deposits at right angles to the substrate with which the septum which has the over hang whose one section or all of a T character cross-section configuration or a cross-section configuration is an inverse tapered shape was formed, and patterning of the second electrode is carried out.

[0007]

[Problem(s) to be Solved by the Invention] Also when using a matrix system, passing through the routing in vacuum devices is indispensable, these processes serve as an element which determines the productivity of a light emitting device, and the second electrode formed the thin film layer containing a luminous layer and on it has effect important for the production cost of a component, also when using mask vacuum deposition.

[0008] This invention solves this problem, improves component productivity, and offers the manufacture approach of the organic electroluminescence devices whose cost can be cut down.

[0009]

[Means for Solving the Problem] In order to attain said purpose, the manufacture approach of the organic electroluminescence devices of this invention is characterized by the following thing. Namely, the process which forms the thin film layer containing the luminous layer which consists of an organic compound at least on the first electrode formed on the substrate, The process which is the manufacture approach of organic electroluminescence devices including the process which forms the second electrode on this thin film layer, and forms the thin film layer of the n-th page (n is two or more integers), and the second electrode on one substrate, It is the manufacture approach of the organic electroluminescence devices characterized by including the process which cuts a substrate after said second electrode formation process at n pieces.

[0010]

[Embodiment of the Invention] The organic electroluminescence devices in this invention are components which the luminous layer which consists of an organic compound at least exists between an anode plate and cathode, and emit light with electrical energy.

[0011] The manufacture approach of the organic electroluminescence devices of this invention is what forms the light emitting device of the n-th page (n is two or more integers) on one substrate at coincidence. The process which forms the thin film layer containing the luminous layer which consists of an organic compound at least on the first electrode formed on the substrate, Including the process which forms the second electrode on said thin film layer, after forming a protective layer after the second electrode formation process or the second electrode formation process, it is characterized by cutting a substrate to n pieces. This manufacture approach can be applied to the organic electroluminescence devices of the structure of arbitration regardless of the numbers of the luminescent color, such as a format of luminescence equipments, such as a single light emitting device, a segmental die, a passive-matrix mold, and a active-matrix mold, and a color, monochrome.

[0012] Patterning of the first electrode can be carried out by the photolithography method if needed using the glass substrate which formed the tin oxide indium (henceforth, ITO) transparent electrode film as the first electrode. Patterning of the first electrode changes with specifications of the light emitting device to form. It is possible for the case of the single component of monochrome to a color display with many pixels to deal with manufacture of various kinds of organic electroluminescence devices.

Although the number of Men which can be arranged from the size of a light emitting device and the size of a substrate which it is going to produce is decided, the purpose of this invention is to form the organic electroluminescence devices of the n-th page (n is two or more integers) on one substrate at coincidence,

also at the lowest, manufactures the light emitting device of the 2nd page on one substrate, after the second electrode formation process, cuts a substrate and obtains n organic electroluminescence devices. [0013] After patterning of the first electrode, at least a part can also form on a substrate a spacer with the height exceeding the thickness of a thin film layer. This spacer can be operated as a septum in a matrix system, can operate as a layer to prevent that a shadow mask damages a thin film layer in mask vacuum deposition, can specify a luminescence field, or can operate the edge part of the first electrode as an insulating layer of a wrap sake.

[0014] Corresponding to the first electrode, the thin film layer and the second electrode containing the luminous layer which consists of an organic compound at least are formed, and organic electroluminescence devices are formed. Although a luminous layer and the patterning method of the second electrode are not limited and a matrix system can also be used, it is desirable to carry out patterning at least of one side with mask vacuum deposition. Selection of the process using mask vacuum deposition can be performed corresponding to the function of the light emitting device which it is going to form. For example, in a monochrome light emitting device, the formation process of the second electrode is suitable. Moreover, in a color display, mask vacuum evaporation is performed at one of processes, and another side can also use a matrix system and can also carry out both patterning processes with mask vacuum deposition. Moreover, even when performing patterning of the second electrode with a matrix system, in order to regulate vacuum evaporation area, a shadow mask is used together in many cases.

[0015] When performing patterning with mask vacuum deposition, where n shadow masks are arranged to one substrate, one [at least] patterning of a luminous layer or the second electrode is carried out. In mask vacuum deposition, although the shadow mask in which opening and the mask section corresponding to patterning which carries out the purpose were formed is arranged in the front face of a substrate and each ingredient is vapor-deposited, in order to form the light emitting device of the n-th page in coincidence with mask vacuum deposition, it is required to arrange each shadow mask corresponding to the light emitting device of the n-th page. Under the present circumstances, if the light emitting device of the n-th page is the same, the thing of a specification also with the same shadow mask will be used. Moreover, the shadow mask of a specification which is different when that from which the patterning specification of the first electrode differs is intermingled will be made to correspond, and it will use.

[0016] Since the shadow mask itself has neither stiffness nor the enough mechanical strength in many cases, it is attached and used for the frame made with enough ingredients of a mechanical strength. By the approach of forming the organic electroluminescence devices of the n-th page (n is the above integer) on one substrate of this invention at coincidence, what attached the shadow mask, respectively is arranged and used for n frames at coincidence. This is called a "division type." In this case, since n shadow masks which became independent, respectively are used, the degree of freedom of exchange of a mask is large, and since alignment of the mask can be carried out according to an individual, respectively, patterning with a high precision becomes possible.

[0017] Another desirable approach can be called a "shoji type." That is, the shadow mask of one sheet is attached in the frame which has n openings, and since it is the relative alignment of the n-th page at the production time of a mask and it is performed, it has the advantage that the reinforcement of that it is not necessary to perform alignment about n-th page each and the whole mask improves.

[0018] It opts for sorting of whether a "division type" is used or to use a "shoji type" in consideration of the size of the organic electroluminescence devices to produce, the number of the components which carry out coincidence formation, the definition of each component, the type of a component, etc. Since each has the above descriptions, selection in which those descriptions are employed efficiently is desirable.

[0019] Although the organic electroluminescence devices of the n-th page (n is two or more integers) produced to one substrate are disconnected after the patterning process of the second electrode and consider as n organic electroluminescence devices, cutting within vacuum devices is difficult and it is desirable to cut, after forming a protective coat on the second electrode, in order to prevent degradation

of the luminescence property by the moisture and oxygen of the open air. As an ingredient of a protective layer, inorganic materials, such as oxidization silicon, an oxidization gallium, titanium oxide, and silicon nitride, various polymeric materials, and the organic material that constitutes organic electroluminescence devices can be used. Silicon nitride is the suitable protective layer ingredient excellent in the barrier property to moisture especially. Although these protective layers are formed by vacuum deposition, the sputtering method, a CVD method, etc., depending on the ingredient to be used, by known approaches, such as mask vacuum deposition, they can carry out patterning of the protective layer, and can also form it. Furthermore, after the second electrode patterning, after cutting to n light emitting devices, a well-known technique may be used and the closure of a luminescence field may be performed.

[0020] although this invention is what produces the organic electroluminescence devices of the n-th page (n is two or more integers) to one substrate at coincidence -- a procedure, and the approach and ingredient of component production to be used -- production per page -- setting -- ** -- it is completely the same. It is shown in sectional view drawing 1 and drawing 2 of typical structure of organic electroluminescence devices to form. The laminating of the electron hole transportation layer 5, the organic luminous layer 6, an electron transport layer 7, and the second electrode (cathode) 8 is carried out on the first transparent electrode (anode plate) 2 formed in the glass substrate 1. What is necessary is not to necessarily limit the configuration of a spacer and just to optimize it according to the purpose, although the spacer 4 is furthermore formed between the second electrode.

[0021] In this invention, it is desirable to form the first electrode in the location which did n division of one substrate corresponding to the organic electroluminescence devices of the n-th page (n is two or more integers), each carries out alignment of formation of subsequent thin film layers, and the formation of the second electrode to this, and they are carried out.

[0022] In this invention, patterning of the first electrode is carried out to two or more stripe-like electrodes which opened predetermined spacing and have been arranged, as for the second electrode, it is desirable to carry out patterning to two or more stripe-like electrodes which cross to them, the intersection of the first electrode and the second electrode serves as a luminescence field, and a matrix is formed.

[0023] Although the mask part used as opening used as a vacuum evaporation part and a non-vapor-depositing part exists in a shadow mask, in the shadow mask corresponding to the stripe-like second electrode pattern, a mask part becomes thin like yarn, and there is a problem that an opening configuration deforms by bending etc., for example. To such a problem, in order to prevent deformation of stripe-like opening, a means to introduce a reinforcement wire and to raise the reinforcement of a shadow mask is adopted so that opening may be crossed. The locations to install differ, and the reinforcement wire arranged at the shadow mask used for formation of the second electrode which functions as a lead wire which followed the reinforcement wire arranged at the shadow mask used for the luminous layer formation formed in the shape of a matrix by the shape of a stripe is devised so that it may be convenient, respectively. Although an example of the shadow mask used for luminous layer patterning at drawing 3 was shown and an example of the shadow mask used for the second electrode patterning at drawing 4 was shown, it is not limited to these.

[0024] The shadow mask corresponding to such a detailed pattern Since the mechanical strengths of the mask part used as the non-vapor-depositing section run short, rather than what attached the shadow mask of one sheet corresponding to the organic electroluminescence devices of the n-th page in the frame which has one opening [whether the shadow mask of n sheets corresponding to the n-th page is attached and used for n frames, respectively, and] The approach of this invention of attaching and using the shadow mask of one sheet which prepared the mask section of the n-th page for the frame which has n openings will be effective for holding the reinforcement and precision of a shadow mask, and will make the manufacture yield of organic electroluminescence devices high as a result. In order to fully demonstrate the effectiveness of this invention, as for the thickness of a shadow mask, it is desirable that it is 500 micrometers or less. the desirable thickness of a shadow mask -- 3 or less times of the width of face of a mask part -- more -- desirable -- 2 double less or equal -- it is . Since the conditions restrained

change with production approaches of a shadow mask when forming and producing the mask section like the case where opening is removed and produced by the etching method, and electroforming, the range of the thickness which can be chosen also differs. Its electroforming is desirable although production of a shadow mask which has detailed mask partial width of face which is used for this invention is not limited to this. In electroforming, the effective aspect ratios of the photoresist used for formation of a detailed pattern are 2-3, in the lower limit of mask ****, the 3 or less times of criteria, then the thickness of a shadow mask are desirable, and they serve as 2 double less or equal more preferably. In for luminous layers, the mask partial width of face of the shadow mask used with the mask vacuum deposition of this invention is about 200 micrometers, and the desirable thickness of the mask to be used is set to 500 micrometers or less. In the shadow mask using a reinforcement wire, that line breadth is about 25 micrometers, and when production of this mask section is taken into consideration, the mask thickness used will have desirable about 50 micrometers.

[0025] The shadow mask used for a luminous layer and the mask vacuum deposition of the second electrode is not especially limited, although produced using metal system ingredients, such as stainless steel, a copper alloy, an iron nickel alloy, and an aluminium alloy, and various resin system ingredients. Since the pattern is detailed, the reinforcement of a mask is not enough, and when it is required to raise adhesion with the substrate of organic electroluminescence devices by magnetism, it is desirable to use a magnetic material as mask material. As the ingredient, quench-hardening magnet ingredients, such as pure iron, carbon steel, W steel, Cr steel, Co steel, and KS steel, Precipitation-hardening magnet ingredients, such as MK steel, Alnico steel, NKS steel, and Cunico steel, Sintered magnet ingredients, such as OP ferrite and Ba ferrite, and the various rare earth magnet ingredients represented by a Sm-Co system and the Nd-Fe-B system, Metal core ingredients, such as silicon steel, an aluminum-Fe alloy, and a nickel-Fe alloy (permalloy), The dust core ingredient which carried out compression molding of the impalpable powder, such as ferrite-core ingredients, such as a Mn-Zn system, a nickel-Zn system, and a Cu-Zn system, carbonyl iron, Mo permalloy, and Sendust, with binding material is mentioned. Although it is desirable to produce a mask from what fabricated these magnetic materials to tabular [thin], what mixed the powder of a magnetic material in rubber or resin, and was fabricated in the shape of a film can also be used.

[0026] Although especially the manufacture approach of a shadow mask is not limited and approaches, such as the mechanical grinding method, the sandblasting method, a sintering process, and a laser process, can be used for it, it is desirable to use the etching method for excelling in process tolerance, electroforming, and the photolithography method. Since electroforming can fabricate a mask part comparatively easily especially, it is the manufacture approach of an especially desirable shadow mask.

[0027] The organic electroluminescence devices of a full color display have red (R), green (G), and three kinds of luminous layers by which patterning was carried out to the field of three blue (B) colors corresponding to the three luminescent color which has an emission peak wavelength. Such one luminous layer patterning of full color organic electroluminescence devices is performed using the shadow mask which formed opening every three pitches in the pitch of the first electrode. After carrying out patterning of the luminous layer of the 1st color, the relative position of a substrate and a shadow mask is moved by one pitch, the luminous layer of the 2nd color is produced, a relative position is moved by further 1 pitch, and the luminous layer of the 3rd color is formed. However, formation of the luminous layer of full color organic electroluminescence devices may also use the approach of not being limited to this approach, dividing mask vacuum evaporation of one luminous layer into 2 times or more, and carrying it out.

[0028] Since a spacer is formed in the condition of touching the first electrode, in many cases, it is desirable to have sufficient electric insulation. What is necessary is just to form the electric insulation part for preventing an inter-electrode short circuit in that case, although a conductive spacer can also be used. It is possible to use an ingredient well-known as a spacer ingredient, and polymer system resin ingredients, such as a polyvinyl system, a polyimide system, a polystyrene system, acrylic, a novolak system, and a silicone system, can be mentioned for oxide ingredients including silicon oxide, a glass ingredient, a ceramic ingredient, etc. as a desirable example with the organic substance in an inorganic

substance. Furthermore, the black matrix-function which contributes to the improvement in display contrast of organic electroluminescence equipment can also be added to a spacer by black-izing the part which touches the whole spacer, a substrate, or the first electrode. As a spacer ingredient in such a case, in order to raise the cascade screen of silicon, gallium arsenide, a manganese dioxide, titanium oxide, chrome oxide, and a chromium metal etc. in an inorganic substance and to raise electric insulation to the above-mentioned resin ingredient in the organic substance, well-known pigments and colors, such as the carbon black system to which surface preparation was performed, a phthalocyanine system, an anthraquinone system, monoazo, a JISUAZO system, metallic complex mold monoazo, a triaryl methane system, and an aniline system, or the ingredient which mixed the above-mentioned inorganic material powder can be mentioned as a desirable example.

[0029] although especially the patterning approach of a spacer is not limited -- after the patterning process of the first electrode -- the whole substrate surface -- a spacer layer -- forming -- well-known FOTORISO -- the approach of carrying out patterning using law is easy in process. Patterning can also be carried out in carrying out patterning of the spacer, using the photosensitive spacer ingredient which made photosensitivity add to the illustrated above-mentioned resin ingredient, direct-exposing a spacer layer and developing it by the etching method or the lift-off method which used the photoresist.

[0030] In order that the first electrode and the second electrode may have a role for supplying current sufficient for luminescence of a component and may take out light, the transparent thing of at least one side is desirable. Usually, use as a transparent electrode the first electrode formed on a substrate, and let this be an anode plate.

[0031] As a desirable transparent electrode ingredient, tin oxide, a zinc oxide, indium oxide, ITO, etc. can be raised. It is desirable to use ITO which was excellent in workability from the purpose which performs patterning.

[0032] The photolithography method accompanied by wet etching can be used for the process which carries out patterning of the first electrode. Especially the pattern configuration of the first electrode is not limited, but should just choose the optimal pattern by the application. It is desirable to carry out patterning of the fixed spacing to two or more stripe-like electrodes opened and arranged in this invention.

[0033] It is also possible to lower the surface electrical resistance of a transparent electrode, or for metals, such as little silver metallurgy, to be contained in ITO for voltage drop control, and to use tin, gold, silver, zinc, an indium, aluminum, chromium, and nickel as a guide electrode of ITO. Especially chromium is a suitable metal from the ability to give the function of both a black matrix and a guide electrode. As for ITO, from a viewpoint of the power consumption of a component, it is desirable that it is low resistance. For example, since supply of the ITO substrate of 10ohms / ** extent is also attained, especially the thing for which a low resistance article is used is desirable [if it is an ITO substrate below 300ohms / ** (transparence substrate in which the ITO thin film was formed), it will function as a component electrode, but] current. Although the thickness of ITO can be chosen according to resistance, it is usually 100-300nm. Especially as for the ITO film formation approach, an electron beam method, the sputtering method, a chemical reaction method, etc. do not receive a limit.

[0034] Although there will be no serious failure in use if visible-ray permeability is 30% or more in a transparent electrode, the direction near 100% is ideally desirable. Although it is desirable to have comparable permeability in the light whole region fundamentally, when the luminescent color wants to change, it is possible to also make light absorption nature give positively. In such a case, the approach of making it discolor using a color filter or an interference filter is technically easy.

[0035] If it has the optical transparency and the mechanical strength suitable for the ingredient of a substrate functioning as a display or a light emitting device, thermal resistance, etc., especially the quality of the material will not be limited. Although plastic sheets and films, such as polymethylmethacrylate, a polycarbonate, and amorphism polyolefine, can be used, it is most desirable to use a glass plate. About the quality of the material of glass, the soda lime glass which gave barrier coating sealant, such as alkali free glass and oxidization silicon film, can be used. Since sufficient thickness to maintain a mechanical strength should be just thick, it is enough if there is 0.5mm or more.

[0036] An acid-resisting function can be added to the first electrode of the above, or a substrate using a well-known technique.

[0037] as a thin film layer contained in organic electroluminescence devices, you may be 1 electron-hole transportation layer / luminous layer, 2 electron-hole transportation layer / luminous layer / electron transport layer, 3 luminous layers / electron transport layer and the luminous layer of the gestalt which boiled the combination matter more than four further, and was mixed, and *****. That is, if the luminous layer which consists of an organic compound as a component configuration exists, it is also good to prepare further the luminous layer which contains the luminescent-material independent or the luminescent material, electron hole transportation ingredient, and electronic transportation ingredient other than the multilayer laminated structure of the above 1-3 like 4.

[0038] An electron hole transportation layer is electron hole transportability matter independent, or is formed with the electron hole transportability matter and a macromolecule binder. As electron hole transportability matter N and N' - diphenyl-N and N' - JI (3-methylphenyl) -1 and 1' - diphenyl - 4 and 4' -- ' - diamine (TPD), N, N' - diphenyl-N and N' - dinaphthyl -1 and 1' - diphenyl -4 and 4' -- the triphenylamines represented by - diamine (NPD) etc. -- N-isopropylcarbazole, a bis-carbazole derivative, a pyrazoline derivative, A stilbene system compound, a hydrazone system compound, the heterocyclic compound represented by an oxadiazole derivative and the phthalocyanine derivative, Although the polycarbonate which has said monomer in a side chain, a polystyrene derivative and a polyvinyl carbazole, polysilane, polyphenylene vinylene, etc. are desirable by the polymer system, it is not limited especially.

[0039] Other than an anthracene, a pyrene, and 8-hydroxy kino RINARU minium, a polyphenylene vinylene derivative, a poly para-phenylene derivative, the poly thiophene derivative, etc. can be used for the ingredient of the luminous layer formed by carrying out patterning on the first electrode by for example, a bis-styryl anthracene derivative, a tetra-phenyl butadiene derivative, a coumarin derivative, an oxadiazole derivative, a JISUCHIRIRU benzene derivative, a pyrrolo pyridine derivative, the peri non derivative, the cyclopentadiene derivative, the thiadiazolo pyridine derivative, and the polymer system. Rubrene, Quinacridone derivative, phenoxazone 660, DCM1, and peri non, moreover, as a dopant added to a luminous layer, perylene, a coumarin 540, a diazaindacene derivative, etc. can use it as it is.

[0040] It is required to convey the electron from cathode efficiently as electronic transportability matter in inter-electrode [which was able to give electric field], electron injection effectiveness is high, and it is desirable to convey the poured-in electron efficiently. For that purpose, an electron affinity is large, moreover electron mobility is large, it excels in stability further, and to be the matter which the impurity used as a trap cannot generate easily at the time of manufacture and use is demanded. As matter which fulfills such conditions, 8-hydroxy kino RINARU minium, hydroxy benzoquinoline beryllium and 2-(4-biphenyl)-5-(4-t-buthylphenyl)- oxadiazole system derivatives, such as 1, 3, and 4-oxadiazole (t-BuPBD), -- 1 of the oxadiazole dimer system derivative which raised thin film stability, 3-bis(4-t-buthylphenyl - 1, 3, 4-oxadizoly) biphenylene (OXD-1), There are 1, 3-bis(4-t-buthylphenyl - 1, 3, 4-oxadizoly) phenylene (OXD-7), a triazole system derivative, a phenanthroline system derivative, etc.

[0041] Although the ingredient used for the above electron hole transportation layer, a luminous layer, and an electron transport layer can form each class independently As a giant-molecule binder, a polyvinyl chloride, a polycarbonate, polystyrene, Pori (N-vinylcarbazole), polymethylmethacrylate, poly butyl methacrylate, Polyester, polysulfone, polyphenylene ether, polybutadiene, Solvent fusibility resin, such as hydrocarbon resin, ketone resin, phenoxy resin, and polyurethane resin, It is also possible to distribute hardenability resin, such as phenol resin, xylene resin, petroleum resin, a urea resin, melamine resin, an unsaturated polyester resin, alkyd resin, an epoxy resin, and silicone resin, etc., and to use.

[0042] The formation approach of organic layers, such as the above-mentioned electron hole transportation layer, a luminous layer, and an electron transport layer, has resistance heating vacuum evaporation, electron beam evaporation, the sputtering method, etc. Although not limited especially, vacuum deposition, such as resistance heating vacuum evaporation and electron beam evaporation, is usually desirable in respect of a property. Although the thickness of a layer cannot be limited since it is

based also on the resistance of an organic layer, it is experientially chosen from for 10-1000nm.

[0043] The cathode used as the second electrode will not be limited especially if it is the matter which can pour an electron into the luminous layer of this component efficiently. Therefore, although use of low work function metals, such as alkali metal, is also possible, considering the stability of an electrode, the alloy of metals, such as platinum, gold, silver, copper, iron, tin, aluminum, magnesium, and an indium, or these metals, and a low work function metal etc. is mentioned as a desirable example. Moreover, minute amount doping of the low work function metal is carried out beforehand at the organic layer, and a stable electrode can also be obtained by forming an after that comparatively stable metal as cathode, keeping electrode injection efficiency high. The method of producing these electrodes also has desirable dry processes, such as resistance heating vacuum evaporation, electron beam evaporation, sputtering, and the ion plating method.

[0044] Although electrical energy mainly points out a direct current, it is also possible to use pulse current and alternating current. Although especially a limit does not have a current value and an electrical-potential-difference value, when the power consumption of a component and a life are taken into consideration, the brightness maximum with the lowest possible energy should be made to be obtained.

[0045]

[Example] This invention is not limited by these examples, although an example is given and this invention is explained hereafter.

[0046] As an object for example 1 luminous-layer patterning, as shown in drawing 3, the mask part and the reinforcement wire produced the 12 same shadow masks formed in the same flat surface. The thickness of 120x84mm and the mask part 31 of the appearance of the shadow mask of one sheet is 25 micrometers, and 272 stripe-like openings 32 with a die length [of 64mm] and a width of face of 100 micrometers are arranged by pitch 300micrometer. The reinforcement wire 33 with a width of face [of 20 micrometers] and a thickness of 25 micrometers which intersects perpendicularly with each stripe-like opening with opening is formed in 1.8mm spacing. Each shadow mask is being fixed to the frame 34 made from stainless steel whose appearance is equal width of face of 4mm. Thus, it divides and uses the produced shadow mask of 12 sheets at a time for 4 sets [3]. This example is at n= 4. The organic electroluminescence devices by the "division type" are produced. In this example, on the substrate, it has arranged the shadow mask of four sheets two four directions at a time, and it was used.

[0047] The four same shadow masks of the structure where a clearance 36 exists between one field 35 of the mask part 31 and a reinforcement wire 33 as an object for the second electrode patterning as shown in drawing 4 and drawing 5 were prepared. The thickness of 120x84mm and a mask part of the appearance of a shadow mask is 100 micrometers, and 200 stripe-like openings 32 with a die length [of 100mm] and a width of face of 250 micrometers are arranged by pitch 300micrometer. On the mask part, the mesh-like reinforcement wire with which spacing of two sides which counters consists of forward hexagon structure which is 200 micrometers 35 micrometers in width of face of 40 micrometers and thickness is formed. The height of a clearance is 100 micrometers equally to the thickness of a mask part. Each shadow mask is fixed and used for the same frame made from stainless steel as the shadow mask for luminous layers.

[0048] Patterning of the first electrode was carried out as follows. The ITO glass substrate (Geomatec make) by which the ITO transparent electrode with a thickness of 130nm was formed in the alkali-free-glass substrate front face with a thickness of 1.1mm by the cathode-sputtering method was cut in magnitude of 240x200mm. The photoresist was applied on the ITO substrate and patterning of the photoresist was carried out by exposure by the usual photolithography method, and development. Since it aimed at forming the organic electroluminescence devices of the 4th page in this example, patterning of the first electrode needed to be performed by the arrangement corresponding to it, and the photo mask used for pattern exposure used that into which the first electrode pattern of the 4th page was packed. Moreover, about each of the 4th page, a pattern formation location can be made to be able to respond to arrangement of the shadow mask for mask vacuum evaporation, and patterning of the pattern exposure can also be repeated and carried out. After etching and removing the garbage of ITO, corresponding to

the organic electroluminescence devices of the 4th page, patterning of the ITO was carried out to die length of 90mm, and a stripe configuration with a width of face of 70 micrometers by removing a photoresist. The stripe-like first electrode per page is arranged 816 in 100-micrometer pitch.

[0049] The spacer was formed as follows. The photosensitive coating agent (the Toray Industries, Inc. make, UR-3100) of a polyimide system was applied on said ITO substrate with the spin coat method, and it acted as the PURIBE king of the 80 degrees C under the nitrogen-gas-atmosphere mind in clean oven for 1 hour. Although pattern exposure is performed on this spreading film through a photo mask, alignment corresponding to the organic electroluminescence devices of the 4th page is performed like the aforementioned first electrode patterning also in this case, using the photo mask of one sheet, pattern exposure is performed and patterning of a photosensitive coating agent is performed according to an individual. development -- the Toray Industries, Inc. make -- using DV-505, after that, for 30 minutes, it baked for 30 minutes and 250 more degrees C of 180 degrees C of spacers which intersect perpendicularly with the first electrode were formed in clean oven. This translucent spacer is 4 micrometers in die length of 90mm, width of face of 50 micrometers, and height, and is arranged 201 in 300-micrometer pitch. The electric insulation of this spacer was good.

[0050] It set to the vacuum deposition inside of a plane, after washing the ITO substrate in which said spacer was formed. It is possible for alignment of a substrate and a mask to be made in the precision of about 10 micrometers into a vacuum, respectively, and to exchange masks in this vacuum evaporation machine.

[0051] The thin film layer containing a luminous layer was formed as follows with the vacuum deposition method by the resistance-wire heating method. In addition, the degree of vacuum at the time of vacuum evaporation is 2×10^{-4} or less Pa, and rotated the substrate to the source of vacuum evaporation during vacuum evaporation.

[0052] First, in arrangement as shown in drawing 6, with the thickness value monitor value by the quartz resonator, the copper phthalocyanine was vapor-deposited to 30nm, the screw (N-ethyl carbazole) was vapor-deposited all over 120nm substrate, and the electron hole transportation layer 5 was formed.

[0053] Next, the mask for luminous layers furnished with the 4th page of the first shadow mask for luminous layers has been arranged ahead [substrate], both were stuck and the ferrite system magnetic shell (the Hitachi Metals, Ltd. make, YBM-1B) has been arranged in substrate back. Under the present circumstances, as shown in drawing 7 and drawing 8, the stripe-like first electrode 2 is located at the core of the stripe-like opening 32 of a shadow mask, and a reinforcement wire 33 is arranged in accordance with the location of a spacer 4 so that a reinforcement wire and a spacer may contact. the shadow mask of the 4th page -- each -- precision -- alignment is performed highly. this condition -- 1, 3, 5 and 7, 8-pentamethyl -4, and 4-difloro-4- a bora -- 43nm (Alq3) of 8-hydroxyquinoline-aluminum complexes which doped -3a and 4a-diaza-s-indacene (PM546) was vapor-deposited, and patterning of the G luminous layer was carried out. [0.3wt%]

[0054] Next, shadow masks are exchanged as well as patterning of said G luminous layer, the 4th page of the second shadow mask for luminous layers is attached, alignment is carried out to the first electrode pattern of the location shifted by one pitch, and it is 1wt% 4-(dicyanomethylene)-2-methyl. - 6 - (JURORIJIRU styryl)- 30nm of Alq(s)3 which doped the pyran (DCJT) was vapor-deposited, and patterning of the R luminous layer was carried out. Shadow masks were exchanged like patterning of said R luminous layer, the 4th page of the third shadow mask for luminous layers was attached, alignment was carried out to the first electrode pattern of the location shifted by further 1 pitch, 40nm (DPVBi) of 4 and 4'-bis(2 and 2'-diphenyl vinyl) diphenyl was vapor-deposited, and patterning of the B luminous layer was carried out. The luminous layer of each RGB has been arranged every three of the stripe-like first electrode, and has covered the exposed part of the first electrode completely.

[0055] Next, in arrangement as shown in drawing 9, DPVBi was vapor-deposited to 70nm and Alq3 was vapor-deposited all over 20nm substrate. The thin film layer was put to the lithium steam, and was doped next (the amount of thickness conversions of 0.5nm).

[0056] The second electrode was formed as follows with the vacuum deposition method by the resistance-wire heating method. In addition, the degree of vacuum at the time of vacuum evaporation is

3×10^{-4} or less Pa, and rotated the substrate to two sources of vacuum evaporation during vacuum evaporation.

[0057] The 4th page of the shadow mask for the second electrode has been arranged ahead [substrate] as well as patterning of said luminous layer, both were stuck and the magnet has been arranged in substrate back. Under the present circumstances, as shown in drawing 10 and drawing 11, both are stationed so that a spacer 4 may be in agreement with the location of the mask part 31. The shadow mask of the 4th page checked alignment separately, and raised precision. Aluminum was vapor-deposited in thickness of 400nm in this condition, and patterning of the second electrode 8 was carried out.

[0058] Finally, in arrangement as shown in drawing 9, silicon monoxide was vapor-deposited all over the substrate with 200nm electron beam vacuum deposition, and the protective layer was formed.

[0059] The substrate with which the light emitting device of the 4th page taken out from the vacuum deposition machine was formed was cut, and it divided into four light emitting devices. The thin film layer containing the luminous layer of each RGB by which patterning was carried out was formed on the ITO stripe-like first electrode of width-of-face [of 70 micrometers], and pitch 100micrometer, and 816 numbers, and the passive-matrix mold color organic electroluminescence devices by which the width-of-face [of 250 micrometers] and pitch 300micrometer stripe-like second 200 electrodes have been arranged so that it may intersect perpendicularly with the first electrode have been produced. Since three luminescence fields, R, G, and B, form 1 pixel, this light emitting device has 272x200 pixels in 300-micrometer pitch.

[0060] This example could perform the vacuum evaporation process required for each patterning to coincidence to four organic electroluminescence devices so that clearly, and manufacture of efficient organic electroluminescence devices was attained by cutting after the second electrode formation.

[0061] The example 2 electron-hole transportation layer was formed, and patterning of G luminous layer and R luminous layer was performed like the example 1. Then, in arrangement as shown in drawing 12, the electron transport layer 7 which vapor-deposits DPVBi to 100nm, vapor-deposits Alq3 all over 20nm substrate, and makes a blue luminous layer serve a double purpose was formed. That is, patterning of B luminous layer was not performed in this example. The thin film layer was put to the lithium steam, and was doped next (the amount of thickness conversions of 0.5nm).

[0062] Cutting after taking out patterning of the second subsequent electrode, and formation and the substrate of a protective layer was performed like the example 1. Thus, the organic electroluminescence devices which have 272x200 pixels in the same 300-micrometer pitch as an example 1 were producible to four-piece coincidence.

[0063] the luminescence field of the produced light emitting device -- the magnitude of 70x250 micrometers -- R, G, and B -- light was emitted to homogeneity in the respectively independent color.

[0064] By repeating this example, every four organic electroluminescence devices can be manufactured for every process. Although damage occurred in the shadow mask of one sheet on the way, the activity has continued repeatedly by exchanging only this shadow mask.

[0065] Formation of example 3 electron transport layer was performed like the example 1. In formation of the second electrode, it intersected perpendicularly with the first electrode, and the spacer whose 201 exist in 300-micrometer pitch was used as a septum in a matrix system, it is formed and the second electrode patterning was performed [the slanting vacuum evaporation of the aluminum was carried out, and] to the field to which a septum exists. The subsequent protection stratification and cutting were performed like the example 1, and four organic electroluminescence devices were obtained. Thus, two or more organic electroluminescence devices can be obtained to coincidence according to a comparatively simple process, and efficient manufacture is attained.

[0066] According to the same process as example 4 example 1, patterning of the first electrode (ITO) was carried out to die length of 90mm, and a stripe configuration with a width of face of 270 micrometers corresponding to the organic electroluminescence devices of the 4th page. The first electrode is arranged 272 in 300-micrometer pitch per page.

[0067] Formation of a spacer and an electron hole transportation layer was made to be the same as that

of an example 1.

[0068] Next, 30nm of Alq(s)3 which doped 0.3wt% PM546 was vapor-deposited, and Alq3 was further vapor-deposited all over 70nm substrate. That is, patterning of the luminous layer was not carried out in this example. The thin film layer was put to the lithium steam, and was doped next (the amount of thickness conversions of 0.5nm).

[0069] Formation of the second electrode and a protective layer and subsequent cutting obtained G luminescence monochrome organic electroluminescence devices of the 4th page like the example 3. The luminescence field of the produced light emitting device emitted light to homogeneity in the magnitude of 270x250 micrometers.

[0070] Thus, also in a monochrome display, two or more organic electroluminescence devices can be obtained to coincidence according to a comparatively simple process, and efficient manufacture is attained.

[0071] Patterning of the example 5 first electrode was performed like the example 1, and the ITO substrate by which patterning was carried out to the arrangement for producing the organic electroluminescence devices of the 4th page was produced. Three shadow masks for luminous layers and one shadow mask for the second electrode corresponding to patterning of this first electrode and arrangement of the organic electroluminescence devices of the 4th page were produced as follows as a "shoji type."

[0072] The mask part and reinforcement wire same as an object for luminous layer patterning as the shadow mask used in the example 1 are in the same flat surface, and that by which 272 stripe-like openings with the mask partial thickness of 25 micrometers, a die length [of 64mm], and a width of face of 100 micrometers have been arranged by pitch 300micrometer produced the photo mask used for patterning of the first electrode, and the shadow mask currently formed the 4th page by collocating. The appearance of the whole shadow mask is fixed and used for the frame made from stainless steel which has the same appearance by 240x184mm. This frame has attached the batch (it is equivalent to the frame of a shoji) with a width of face [for turning opening length and sideways for 2 minutes] of 4mm.

[0073] That by which 200 stripe-like openings with the thickness of 100 micrometers of a mask part, a die length [of 100mm], and a width of face of 250 micrometers have been arranged by pitch 300micrometer produced the photo mask used for patterning of the first electrode, and the shadow mask currently formed the 4th page by collocating with the structure where a clearance exists between one Men of the same mask part, and a reinforcement wire with having used in the example 1 also as an object for the second electrode patterning. On the mask part, the mesh-like reinforcement wire with which spacing of two sides which counters consists of forward hexagon structure which is 200 micrometers 35 micrometers in width of face of 40 micrometers and thickness is formed. The appearance of this whole shadow mask is 240x168mm, and is being fixed to the frame which has four openings made from stainless steel like the shadow mask of patterning for luminous layers.

[0074] Patterning of the first electrode was performed like the example 1 as aforementioned.

Furthermore, the spacer as well as an example 1 was produced. Thus, after washing the processed ITO substrate, it set to the vacuum deposition inside of a plane, and three shadow masks for luminous layers corresponding to the organic electroluminescence devices of the 4th page produced as further aforementioned and one shadow mask for the second electrode were set to the vacuum deposition inside of a plane.

[0075] Formation of an electron transport layer was carried out according to the example 1 to patterning of formation of an electron hole transportation layer, G luminous layer, R luminous layer, and B luminous layer, and a pan. Then, cutting after taking out patterning of the second electrode, formation of a protective layer, and a substrate as well as an example 1 was able to produce the organic electroluminescence devices of four sheets to coincidence. By using this "shoji type" of shadow mask, there was an advantage that the time and effort of the alignment between the 4th page could be saved, and efficient component manufacture was possible.

[0076]

[Effect of the Invention] This invention can produce the organic electroluminescence devices of the n-th

page (n is two or more integers) on one substrate at coincidence, and improvement in productive efficiency can be attained by cutting a substrate to n pieces after the second electrode formation process.

[Translation done.]